A Regionally Explicit Phosphorus Balance of Denmark – Focus on Agriculture

Klinglmair, Manfred

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

DTU Environment
Department of Environmental Engineering

Aim

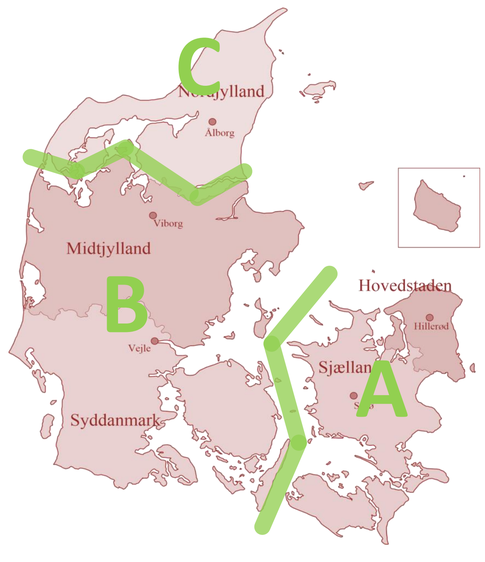
Part of the IRMAR project (Integrated Resource Management and Recovery; DTU, TU Vienna, ETH Zürich) is to map the flows of critical resources in Denmark.
One such resource is phosphorus, the supply, pathways, stocks, and losses of which have been examined on a national or supra-national level in various recent studies. With approx. 90% of an economy's P turnover, agriculture is the focus of our study. In addition, waste streams are often discussed as still holding significant potential for nutrient recovery.

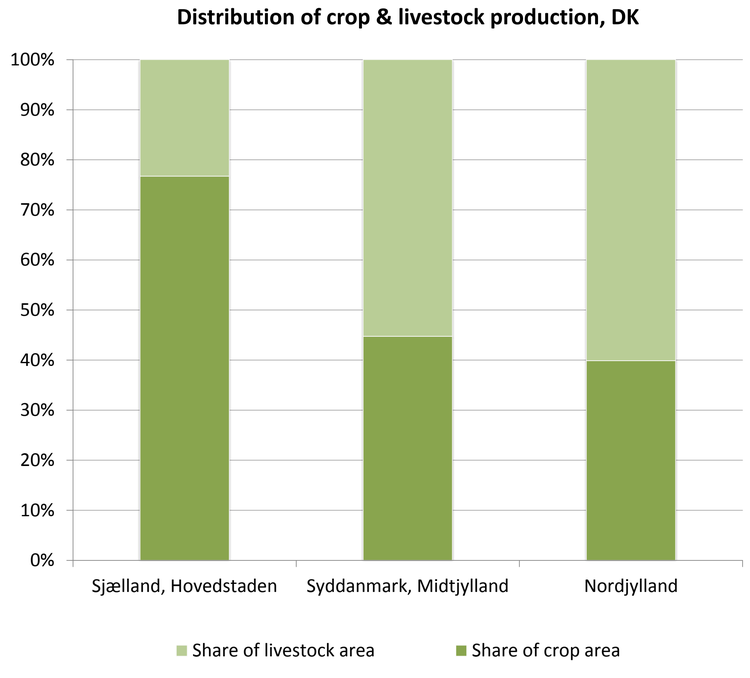
Within an economy, the applied amounts of phosphorus in agriculture may vary significantly; national-scale material flow models do not adequately capture these differences.
Using additional data on phosphorus concentrations in soils and regional data on agricultural practices (e.g. crops, animal husbandry) and waste management, we introduce regional differentiation in the Danish P household.

Methodology

By looking at sub-national regions, a more meaningful picture of the system of phosphorus stocks and flows can be provided.
We draw on statistical data from trade and waste management to establish a model of flows and stocks for Denmark; 3 regional subsystems for the processes "agriculture" and "waste management" based on pronounced differences in agricultural practice are established.
Two regions with significantly different soils and agricultural production (clay soils/crops in Zealand [**A**], sandy soils/animals in Northern Jutland[**C**]) are of particular interest; a third region (Fyn, Mid- and Southern Jutland [**B**]) combines these characteristics within the region, presenting a more mixed picture.

To model the flows, the STAN 2.5 software for Material Flow Analysis (MFA) is used. Processes examined are industry & trade, households, waste water treatment, waste management, and agriculture; the latter 3 on a regional scale. Our aim is to map the generation and flows of organic waste and sewage sludge in these 3 regions are and present them as an integrated part of a country-scale substance flow analysis.
Our focus is on regional differences in the phosphorus household due to differing extent of use in agriculture: different transfer coefficients and P stock dynamics in agriculture-related processes in a substance flow analysis (SFA) system.





Results

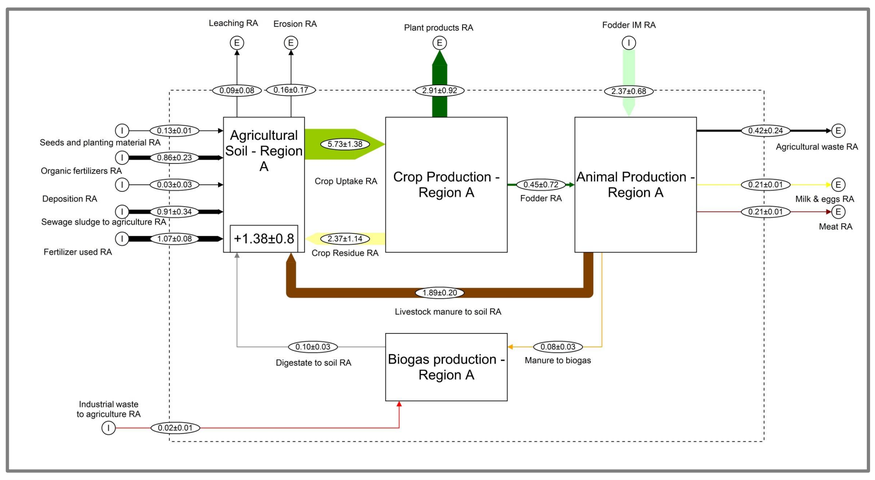
A farm/region-specific quantitative phosphorus household was obtained ; it is to be linked to regional waste management processes to generate an integrated picture of phosphorus flows and stocks in Denmark.

On the right are the preliminary MFA models for the process "Agriculture", showing the regional differences between the regions examined.
National statistics show an annual net phosphorus input of 3-4 kgP/ha; our mass balance shows that this accumulation is most pronounced in Nordjylland (C) with 60% of the agricultural are being used for livestock farming.
This results in a limited capacity of crop production in that region to take up phosphorus from the manure produced.

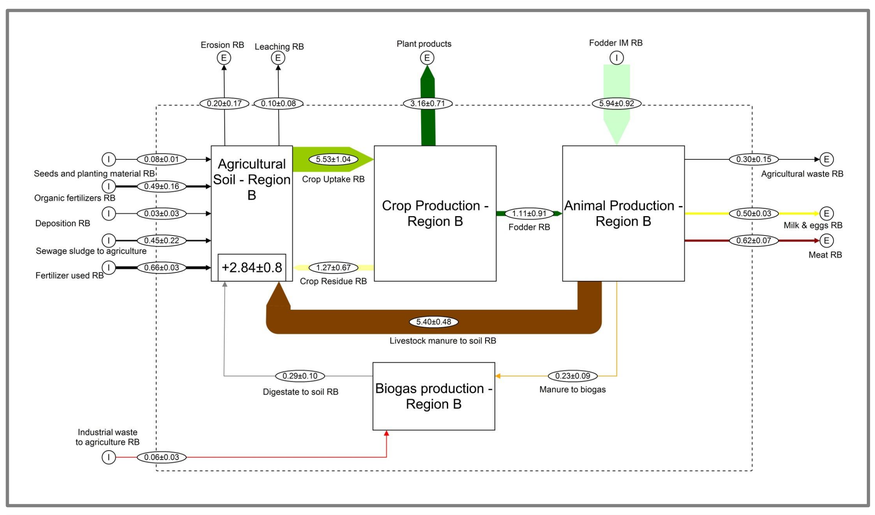
Three major sources of data uncertainty exist:
1) transport of goods within the country; this applies mostly to domestically produced fodder,
2) the amount of agricultural waste not remaining in the the agricultural system, or transport of agricultural waste between regions, and
3) 20-25% of the substrate in joint & farm-scale anaerobic digesters/biogas plants consists of organic industrial waste; the distribution of this waste within the country was estimated based on the number and capacities of joint & farm-scale plants in each region.

Use on land of digestate from joint & farm-scale biogas plants is playing a negligible role across all regions examined.

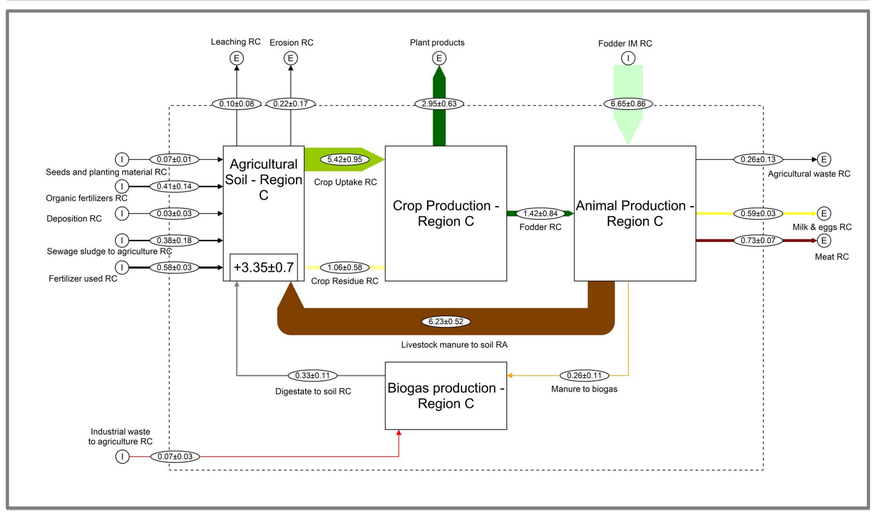
A: Sjælland, Hovedstaden: kg P/ha, 2011



B: Syddanmark, Midtjylland: kg P/ha, 2011



C: Nordjylland: kg P/ha, 2011



Conclusions

This is an ongoing project; definitive conclusions are difficult to reach at this point.

The preliminary results show, however, to Denmark's "manure problem": there is a pronounced imbalance of manure production from animal husbandry, concentrated in region C, and crop production, concentrated in region A.
Field P balances indicate a P surplus of about 25kg P/ha for region A, with a negative balance in region C.

At present, manure is barely transported within the country to make use of surplus manure in areas dominated by crop production; typical distances are 20-30km.

A focus of further work will be to evaluate the potential for making surplus manure and agricultural waste, or products thereof, available across regions to optimize the system of flows on the national scale with a view to maximizing re-use of agricultural waste materials.

Contact

Contact:
Manfred Klinglmair, PhD Student
DTU Environment
Miljøvej, Building 113
DK-2800 Kongens Lyngby

mank@env.dtu.dk

www.3R.env.dtu.dk
www.env.dtu.dk

IRMAR
Integrated Resource Management and Recovery